

The McGill Integrated Safety Seat  
and  
ZUSCHATD Project

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The following is background information for the presentation by A.L. Thompson at the Workshop to be held under the auspices of SAE STAPP on October 16, 1988 at Atlanta, Ga. The purpose of this presentation is to attempt to examine the criteria for an appropriate ATD for testing of the McGill Integrated Safety Seat (MISS) particularly when installed in vehicles where the intrusion may be more severe than anticipated in crash tests and the researcher does not want to risk partial or complete damage to the Eurosid ATD (worth about \$100,000 Canadian) or other type of expensive ATD. The ZUSCH ATD (towards the ultimate anthropometric device) is recommended for consideration for tests of all modes of severe vehicle collisions.

Transport Canada has contracted with 10 University-based MDAI teams across the country since about 1970 to study automotive accidents, initially about 20/year/team in detail as well as other special studies and to investigate potential defects. Since 1980 the program has been changed to about 100 statistically sampled accidents per year per team to provide coded information on accidents in less detail. These accidents involved Light Trucks and Vans (LTV) during 1980-84 and Passenger Cars (PCS) since 1984. All of this effort has provided a wealth of information which indicates where improvements should be made in the various aspects of road safety for the reduction of fatalities and injuries.

McGill University was one of the first Multi-disciplinary Accident Investigation (MDAI) teams to be established partly because McGill was the first Canadian University to be involved in Traffic Accident Research when Dr. Harold Elliott and his colleagues organized a Conference in 1955. The author became involved in 1966 when he attended a Conference or Workshop in Ottawa to establish guidelines for Vehicle Safety Standards.

During the period 1970-80 automotive accident data obtained by the McGill MDAI team (often from on-scene investigations) and by the other University-based Canadian teams provided the basis for very worthwhile recommendations which were eventually adopted such as: improved Vehicle Safety Standards, improvements in the highway such as proper concrete dividers to prevent crossing over of vehicles, breakaway posts, etc. Recommendations were also provided on road safety for Québec to the Gauvin Commission on Automobile Insurance. Studies supported by contracts from Transport Canada were conducted on buses and trucks, in particular, accidents involving air-braked vehicles, fully restrained front seat occupants of vehicles and on the use and suitability of available vehicle and auxiliary restraint systems for the protection of child passengers in crash situations (supported by the Ministry of Consumer and Corporate Affairs of Canada).

The author (in addition to planning and directing the accident investigation program aided most capably by the excellent McGill team coordinator, Diana Steiner) has kept reviewing the information being accumulated in Canada as indicated in the first paragraph and the many publications from researchers in other countries. From valued discussions with Canadian colleagues and other researchers the author has been able to initiate research and development of many automotive safety related topics. Since 1975 he has supervised about 100 senior undergraduate students in experimental and design projects. Frequently the author's Honorarium from the contract on Accident Investigation has been utilized to support these projects since other funds were not adequate or available to provide the equipment or supplies or overtime work by technicians to help provide an excellent educational experience and training in research and development for many students. Gratitude is expressed to Transport Canada (particularly the Test Centre) for the loan of very valuable equipment from time to time and for excellent technical advice from TC staff.

Some of the goals of this work have not yet been achieved, particularly a device defined as an Accelerecordat (a mass on the end of a rod) whose angle of bending during a crash when measured carefully afterwards by an investigator would give some idea of the direction and rate of deceleration of the vehicle and hence a better measure of the "g" forces which a restrained occupant had experienced during the crash. The device could also be utilized to indicate positively whether the occupant had been utilizing the restraint system or not during the accident. Unfortunately the Accelerecordat has not yet been developed to an acceptable state of dependability, particularly if one considers the potential cost which can be justified to install one in every vehicle on the road. Dr. Ian Jones of the Insurance Institute of Highway Safety has suggested a cost of one dollar. The author believes that a cost of \$10 or more is justified in Canada at least when one considers the potential resulting improvement in accident data and the potential reduction of the overall cost of accidents, medicare etc. to encourage every occupant of a vehicle to utilize the present or an improved restraint system. A modified approach based on a Swedish development which measures the maximum angle of bending during the crash has promise of being more reproducible and reliable. It is expected that by November the author will be able to report on this development and also on the project by other students on a compact economical device to record the length of time (in milliseconds) of the crash of a vehicle.

Many students have been involved in designing, building and testing the McGill Integrated Safety Seat (MISS 1,2,3,4 etc.) where the restraint system is attached directly to a reinforced frame which may be supported by a belt attached to the roof of the vehicle.

Progress has been delayed because of lack of funds. MISS is intended to be a vehicle seat with an integrated restraint system which will provide maximum protection for an occupant of a vehicle in any type of severe collision i.e. frontal, near side, far side, rear end or roll over with a dependable quick release mechanism even if a fire occurs after the vehicle is severely crushed. It is also important from the view point of maximum use of the restraint system that it is attractively easy to restrain oneself and is as comfortable as possible for all percentiles of occupants from 5th percentile female to 95th percentile male. The presentation will describe with the aid of slides and schematics different reinforced steel seat frames which have been constructed and 3 different restraint systems: a) double buckle 4 point, b) double 3 point and c) 3 point plus \* 2 point (belt systems). The term 3 point means that the restraint system is the same as used in vehicles now but with MISS is attached directly to the frame of the seat and not to the B-pillar of frame of the car and to the floor. This provides better protection for the vehicle occupant in the event of a near side collision.

The examination of about 1000 accidents in Transport Canada's PCS file to date indicates that in about 1/2 of the accidents where a vehicle occupant has experienced severe injuries (AIS3 or greater) and/or been fatally injured where there was severe intrusion etc. MISS would have been very beneficial.

If time permits a socioeconomic study to attempt to justify MISS will be outlined.

\* See Appendix A by W. Kreklewetz who was a research assistant of the author (ALT) May-August, 1988.

#### Acknowledgements:

The author wishes to thank all who have helped this research program (which started in 1966) both financially, doing experimental and investigative work and contributing all types of talents and expertise to help ensure success for improved automotive and road safety. In particular he appreciates the role of Transport Canada, Ford Motor Company of Canada, Diana Steiner, McGill Team Coordinator, various accident investigators, research assistants and about 100 senior undergraduate students who have worked on supplementary projects over the years. The opinions expressed in this paper are those of the author (A.L. Thompson) and not necessarily those of Transport Canada.



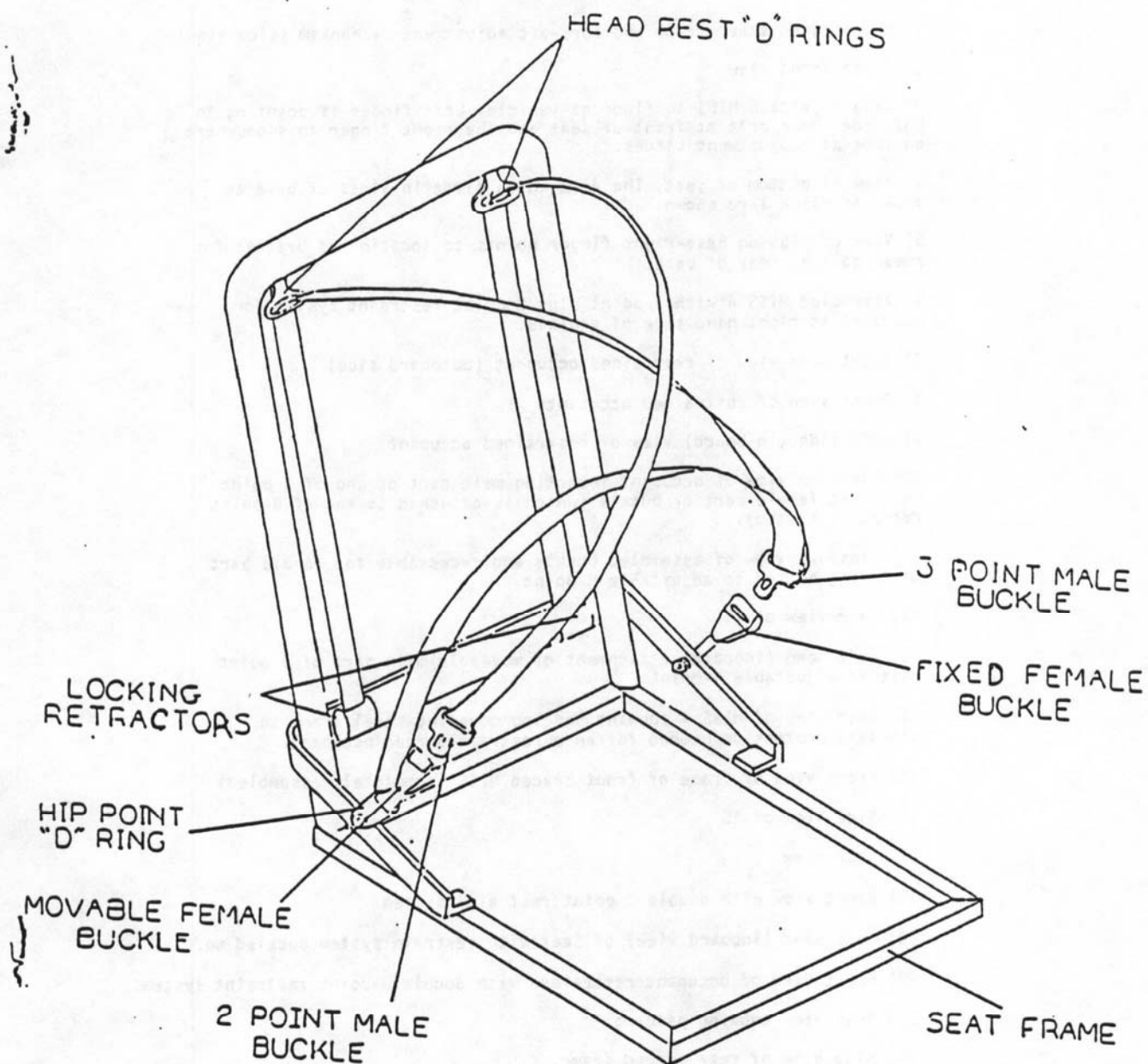
## APPENDIX A

The design of this restraint system (3 point plus 2 point) to be integrated with the metal frame of the McGill Safety Seat was initiated by the author (W.K.) as a desirable alternative to the double 3-point restraint system which might produce some difficulty for some vehicle occupants because of the two lap belts.

The three point plus two point restraint system has two separate belt assemblies (see Schematic and photos). One of these resembles a standard three point shoulder harness and lap belt. A spool type locking retractor is located on the back of the seat close to the floor and offset to the right of centre. The belt extends from the retractor up the back of the seat to a "D" ring attached to the right side of the seat back frame at the height of the head rest. From here the belt passes through the "D" ring and continues down the front of the seat to the hip point on the right side of the seat. Instead of being fixed solidly to the seat frame at the hip point like a standard three point harness, the belt passes through another "D" ring which is attached to the frame at this location. A female buckle is fitted to the free end of the belt and the tension applied by the spring in the retractor keeps this movable female buckle drawn down against the hip point "D" ring. There is a male buckle on the section of belt between the head rest and hip point "D" rings that is free to slide along the belt. At the left side hip point location there is another female buckle that is fixed solidly to the seat frame. When the belt is drawn across the torso from right to left and the male buckle is connected to this fixed female buckle the system functions exactly like a standard three point harness.

The second belt assembly (two point) has a spool type locking retractor located similarly to that of the three point but offset to the left of centre. The belt runs from the retractor up the back of the seat and passes through a "D" ring attached to the left side of the seat frame at the height of the head rest. At this point the belt terminates with a male buckle. This male buckle can be connected to the movable female buckle at the right hip point so that the belt passes diagonally across the torso from left to right. Hence, the two belt assemblies cross the chest and are attached at the hip points in such a way that any tension induced in the belt sections that pass over the upper torso tends to tighten the section that passes across the lap, and to reduce the possibility of submarining.

To prevent the inadvertent use of the two point assembly without the three point, an interlock is recommended. The interlock could take the form of an electric switch in the fixed female buckle that is connected to a brake on the two point retractor. The brake would prevent the two point belt from being extracted from the retractor unless the male buckle on the three point belt was inserted into the fixed female buckle. Work is still in progress on a physical system which would be preferable and hopefully less expensive than the above proposed electrical system.



SCHEMATIC OF MCGILL INTEGRATED SAFETY SEAT  
 USING THREE POINT PLUS TWO POINT SYSTEM (For RF  
 Occupant)

A 2

DRAWN BY BILL KREKLEWETZ 23/61

McGill Integrated Safety Seat (MISS) Description of Slides. (to be shown)

- 1) Rear-braced steel frame and fore-aft adjustment mechanism (side view)
- 2) Ditto front view
- 3) Base to attach MISS to floor of vehicle. Left finger is pointing to hole for shear bolt at front of seat and the right finger to slot where 1 on fore-aft adjustment slides.
- 4) View of bottom of seat. The 4 1 which slide in slots of base as shown in slide 3 are shown.
- 5) View of MISS on Base-right finger points to location of bracket for shear bolt at rear of base.
- 6) Assembled MISS 4 with 3 point plus 2 point restraint system for occupant at right hand side of vehicle.
- 7) Right side view of restrained occupant (outboard side)
- 8) Front view of restrained occupant
- 9) Left side (in-board) view of restrained occupant.
- 10) Close-up view of occupant inserting male part of end of 2 point belt into female part of buckle (which is attached to end of 3-point restraint system).
- 11) Close-up view of assembled buckle and receptacle for female part of D-ring bolted to adjustable H-point.
- 12) Rear view of 11.
- 13) Left hand (inboard) attachment of moveable male part of 3 point belt at adjustable H-point.
- 14) Rear view of MISS 4 showing padding covering steel frame to simulate protection needed for an unrestrained rear occupant.
- 15) Front view of frame of front braced MISS (completely assembled)
- 16) Side view of 15
- 17) Rear view
- 18) Front view with double 3 point restraint system
- 19) Left hand (inboard view) of seat with restrain system buckled up.
- 20) Front view of occupant restrained with double 3-point restraint system.
- 21) Rear view showing padding
- 22) Side view of rear braced frame.
- 23) Front view of 3 components of front-braced steel frame.
- 24) Side view of assembled frame of front braced MISS.
- 25) Front view of assembled frame.
- 26) Occupant restrained with double buckle 4 point restraint system.
- 27) Repeat of 26 - no occupant (front view)
- 28) Repeat of 27 - side view.
- 29) Side view of occupant restrained with double buckle 4 point system.